Acquisition Research Program:
Creating Synergy for Informed Change

The Impact of Collaborative and Three Dimensional Imaging Technology on SHIPMAIN Cost Estimates

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Introduction

- The U.S. Navy (Navy) owns 277 ships, 57 submarines and more than 4,000 aircraft that requires an inventory that includes: 551 different engines; 7,325 different motors; 36,979 types of valves; 268 air-conditioning unit models and ; 443 categories of generators. (Erwin, 2007)
- Research was conducted into the efficiencies and added value that could be realized by incorporating 3D laser scanning and Product Lifecycle Management (PLM) tools into the cost estimation portion of the ship maintenance and modernization (SHIPMAIN) program.
- Knowledge Value Added (KVA) + Real Options (RO) framework was used in a proof-of-concept case study to quantify process improvements and subsequent benefits of the addition of 3D laser scanning and PLM technologies on cost estimation in the SHIPMAIN program.

Maintenance and Modernization- The Cost Question

- For FY08, the Navy has requested $5.5 billion for maintenance to support the Fleet Commanders.
- The Navy's next generation fleet (313 ships) will require an average annual shipbuilding investment of $13.4 billion in Fiscal 2005 dollars. (Goddard, 2007)
- Because the complexity of the current and future ship-force, required design periods for these new systems can range from five to ten years from concept to initial construction. When one considers that the actual construction will add two to seven more years, proper planning and diligence becomes even more crucial to the cost estimation portion of the program.
- The Entitled Process for Surface Ship and Carrier Modernization (SHIPMAIN EP) is a five-phased program that leverages best practice techniques to provide a common planning process for fleet maintenance. The goal of this program is the "right" work at the "right" time for the "right" cost.
- Cost-estimation is just one area in the SHIPMAIN where the Navy can become significantly more accurate and efficient.

Knowledge Value Added and Real Options Analysis

- Measures value and cost of human and IT assets.
- Uses a “market comparables” valuation technique to establish revenue surrogates for discounted cash flow estimates.
- Allows for use of powerful financial metrics in forecasting value of strategic options of potential IT acquisitions.
- Estimates value and risk of strategic options using real options analysis (Hammer, 2007; measures drivers of value and risk).

Knowledge Value Added + Real Options Framework

Analyzes/Forecasts Risks and Projects Potential Value

REAL OPTIONS ANALYSIS

- Risk Identification: *List projects and strategies to evaluate.*
- Risk Prediction: *Base case projections for each project.*
- Risk Modeling: *Develop static financial models.*
- Risk Analysis: *Dynamic Monte Carlo simulation.*
- Risk Mitigation: *Frame real options.*
- Risk Hedging: *Options analytics, simulation & optimization.*
- Risk Diversification: *Portfolio optimization and asset allocation.*
- Risk Management: *Iterative analysis.*

Captures Process Data

KVA METHODOLOGY

- Identify/Measure outputs.
- Calculate learning time for each sub-process.
- Derive costs and revenues for each sub-process.
- Calculate metrics:

  Return on Investment (ROI)

  Return on Knowledge (ROK)

Establishes Market Comps

DATA COLLECTION

- Collect baseline data.
- Conduct interviews with subject matter experts.
- Identify sub-processes.
- Research market comparable data.
- Conduct market analysis.

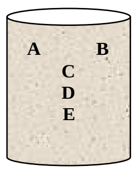
KVA Methodology Process Steps

1. Identify core processes and sub-processes.
2. Establish common units and level of complexity to measure learning time.
3. Calculate learning time (i.e., knowledge surrogate) to execute each sub-process.
4. Designate sampling time period long enough to capture representative sample of the core processes' final product or services output.
5. Multiply learning time for each sub-process by number of times sub-process executes during sample period.
6. Calculate cost to execute knowledge (learning time and process instructions) to determine process costs.
7. Calculate ROK (ROK= Revenue/Cost) and ROI (ROK= Revenue-Cost/Cost).

Real Options Analysis

RISK IDENTIFICATION

1. List of projects and strategies to evaluate



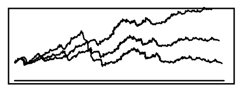
Start with a list of projects or strategies to be evaluated… these projects have already been through qualitative screening

RISK PREDICTION

2. Base case projections for each project

Historical Data Gathering

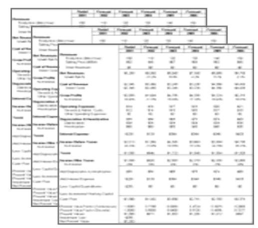
Time Series Forecasting



…will the assistance of time-series forecasting and historical data…

RISK MODELING

3. Develop static financial models with KVA data



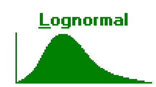
…the user generates a traditional series of static base case financial (discounted cash flow) models for each project…

Traditional analysis stops here!

RISK ANALYSIS

4. Dynamic Monte Carlo simulation

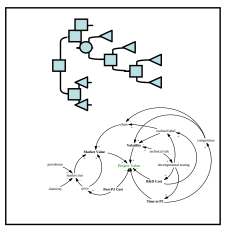
Simulation



…sensitivity and scenario analysis coupled with Monte Carlo simulation is added to the analysis and the financial model outputs become inputs into the real options analysis…

RISK MITIGATION

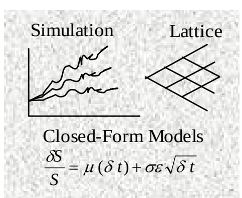
5. Framing Real Options



…the relevant projects are chosen for real options analysis and the project or portfolio real options are framed…

RISK HEDGING

6. Options analytics, simulation and optimization

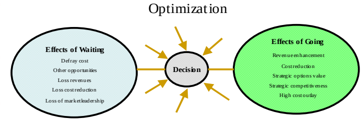


…real options analytics are calculated through binomial lattices and closed-form partial-differential models with simulation…

RISK DIVERSIFICATION

7. Portfolio optimization and asset allocation

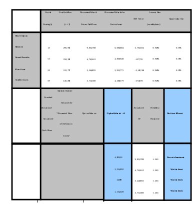
Optimization



…stochastic optimization is the next optional step if multiple projects exist that requires efficient asset allocation given some budgetary constraints… useful for strategic portfolio management…

RISK MANAGEMENT

8. Reports presentation and update analysis



…create reports, make decisions, and do it all again iteratively over time…

Case Study Methodology

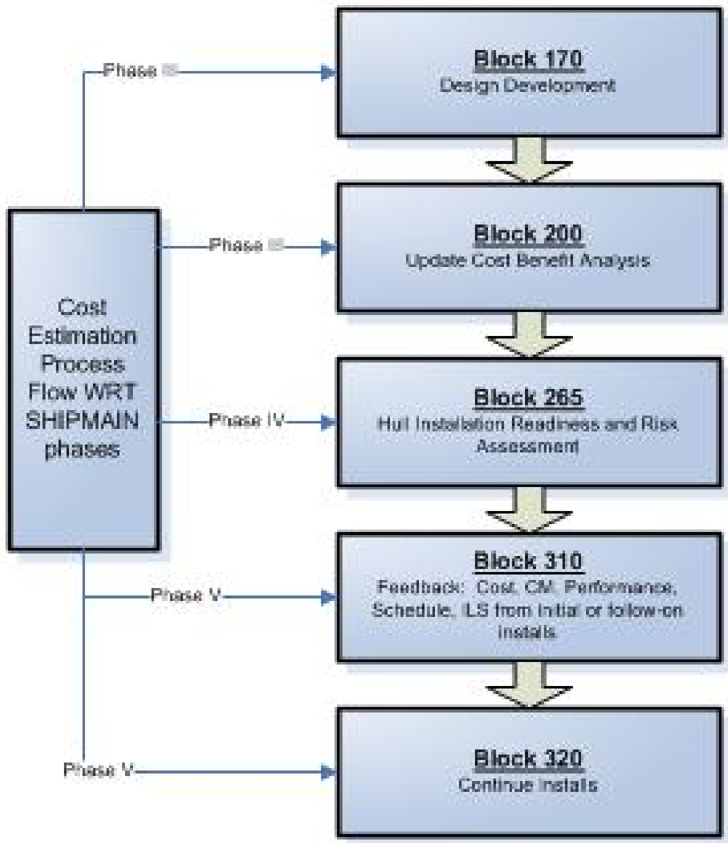
- KVA+RO framework applied in case study analyzing potential effects of 3D terrestrial laser scanning and PLM technologies on SHIPMAIN cost estimation.
- Current “As-Is” processes compared with “To-Be” processes.
- Quantitative scope of research limited to cost estimation portion of SHIPMAIN.
- Data used in analysis derived from interviews with Subject Matter Experts, surveys and secondary research.

Projected Benefits

- The addition of 3D terrestrial laser scanning and PLM technologies to the SHIPMAIN program will allow for the creation of a central repository containing incredibly accurate models of ship spaces (a leap beyond the current 2D drawings). This will result in increased efficiencies and value to the cost estimation process.

- Anticipated benefits include:
  – Cost estimation accuracy
  – Cost savings
  – Better lifecycle planning
  – Increased ROI

SHIPMAIN Cost Estimation Process Flow



Case Study Results: Costs, Benefits, ROI

Core Process	Process Title	Annual As-Is Cost	Annual As-Is Benefits	Annual To-Be Cost	Annual To-Be Benefits	As-Is ROI	To-Be ROI
170	Design Development	$214,570,062	$360,388,939	$91,999,022	$539,639,982	67%	487%
200	Update Cost Benefit Analysis	$1,129,316	$5,660,559	$432,559	$11,321,119	505%	2517%
265	Hull Installation Readiness and Risk Assessment	$95,146,354	$57,991,301	$42,612,154	$ 106,168,950.08	-39%	149%
310	Feedback: Cost, CM, Performance, Schedule, ILS from Initial or follow-on Install	$1,548,345	$1,132,112	$179,362	$2,264,224	45%	1162%
320	Continue Installs	$780,361	$2,830,280	$1,936,999	$6,792,671	-27%	251%
	Totals:	$313,174,438	$428,003,191	$137,160,097	$666,186,946	35%	386%

Case Study Results

- *Enhanced Lifecycle Planning.* With no single repository of data tracking an individual warship from cradle to grave, the addition of 3D laser scanning and PLM technologies facilitates the creation of a single source tracking mechanism. The repository could consolidate as-designed, as-planned, as-built and as-maintained warship data into a single record of the respective ship.
- *Greater Cost Estimation Accuracy.* A central repository enables more informed, accurate cost estimation decisions. Highly accurate models generated by 3D laser scanning enables greater accuracy in cost estimates because the ship/space will be correctly represented in exacting detail.
- *Significant Cost Savings.* The U.S. Navy currently spends over $313 million per year on labor to complete 655 SCDs. Costs drop to just over $137 million with the technologies, saving more than $176 million per year.
- *Increased Benefits.* Annual benefits increased from over $428 million to just over $666 million.
- *Optimized ROI.* The potential ROI is 386%, compared to 35%.

Real Options Results

Strategic Option		Static Net Present Value	Total Strategic Value	ROI	Strategic Option Value	Factor Increase to Base Case
A	Current System (Do Nothing)	($890,063,204)	($890,063,204)	-36.81%	N/A	N/A
B	Implement all processes immediately	$1,319,508,759	$1,319,508,759	124.59%	N/A	2.81
C	Stage-gate implementation	$1,056,660,389	$1,596,169,863	125.46%	$539,509,474	6.24

Research Implications

- 3D laser scanning and PLM technologies offers significant value when applied to the cost estimation portion of the SHIPMAIN environment.
- The combination of high-quality, reliable, accurate and reusable digital 3D data captured from the laser scanner and PLM, with its' information storage, distribution and collaboration capabilities, could provide the optimum mechanism for tracking product data of U.S. Navy ships from concept to decommission.

Questions?